

WHAT IS CLAIMED IS:

1 1. A method, the method comprising:

2 using ion beam deposition to deposit a first multilayer stack of thin films on a
3 substrate to planarize and smooth surface defects on the substrate; and

4 using atomic layer deposition to deposit a second multilayer stack of thin films on the
5 first multilayer stack of thin films, the second multilayer stack of thin films comprising an
6 extreme ultraviolet reflective multilayer stack.

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8 2. The method of Claim 1, wherein the first multilayer stack of thin films comprises
9 alternating layers of thin film layers, the alternating layers of thin film layers comprise one of
10 Molybdenum and Silicon thin films, Molybdenum and Beryllium thin films, and
11 Molybdenum and Silicon compound thin films, wherein the Silicon compound comprises one
12 of Silicon Nitride and Silicon Dioxide.

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14 3. The method of Claim 1, wherein the second multilayer stack of thin films comprises
15 alternating layers of thin film layers, the alternating layers of thin film layers comprise one of
16 Molybdenum and Silicon thin films, Molybdenum and Beryllium thin films, and
17 Molybdenum and Silicon compound thin films, wherein the Silicon compound comprises one
18 of Silicon Nitride and Silicon Dioxide.

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20 4. The method of Claim 1, wherein the first multilayer stack of thin films comprises 20
21 to 40 alternating layers of thin film layers, wherein the alternating layers of thin films
22 comprise a first film and a second film with different optical properties.

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24 5. The method of Claim 1, wherein the second multilayer stack of thin films comprises
25 40 to 60 alternating layers of thin film layers, wherein the alternating layers of thin films
26 comprise a first film and a second film with different optical properties.

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28 6. The method of Claim 1, wherein the second multilayer stack of thin films comprises
29 fewer surface defects than the first multilayer stack of thin films.

31 7. The method of Claim 1, further comprising processing an extreme ultraviolet mask
32 blank to form an extreme ultraviolet reflective mask.

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34 8. The method of Claim 7, the processing an extreme ultraviolet mask blank to form an
35 extreme ultraviolet reflective mask comprising:

36 depositing a buffer layer on the second multilayer stack of thin films;

37 depositing an absorber layer on the buffer layer; and

38 depositing a resist layer on the buffer layer.

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40 9. The method of Claim 8, the processing an extreme ultraviolet mask blank to form an
41 extreme ultraviolet reflective mask further comprising:

42 patterning and developing the resist layer;

43 patterning the absorber layer;

44 removing the resist layer; and

45 patterning the buffer layer.

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47 10. An apparatus, the apparatus comprising:

48 a substrate;

49 a first multilayer of films on top of the substrate to form a flat top surface by a first
50 deposition process; and

51 a second multilayer of films on top of the first multilayer of films, the second multilayer
52 of films effectuating a Bragg reflector to reflect extreme ultraviolet radiation, the second
53 multilayer of films being deposited with a second deposition process.

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55 11. The apparatus of Claim 10, wherein the first and second multilayers of films comprise
56 alternating layers of films, wherein the alternating layers of films comprise a first film and a
57 second film with different optical properties.

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59 12. The apparatus of Claim 11, wherein the first and second multilayers comprise one of
60 Molybdenum and Silicon films, Molybdenum and Beryllium films, and Molybdenum and

61 Silicon compound films, wherein the Silicon compound comprises one of Silicon Nitride and
62 Silicon Dioxide.

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64 13. The apparatus of Claim 11, wherein the substrate comprises a low thermal expansion
65 substrate.

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67 14. The apparatus of Claim 11, wherein the first deposition process is an ion beam
68 deposition process, and the second deposition process is an atomic layer deposition process.

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70 15. The apparatus of Claim 11, wherein the first multilayer of films smooths surface
71 defects on the substrate.

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73 16. The apparatus of Claim 15, wherein the first multilayer of films planarizes and
74 smooths surface defects of 50nm or less on the substrate.

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76 17. The apparatus of Claim 16, wherein the first multilayer of films comprises a range of
77 20 to 40 alternating layers of films.

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79 18. The apparatus of Claim 11, wherein the second multilayer of films comprises a range
80 of 40 to 60 alternating layers of films.

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82 19. The apparatus of Claim 10, wherein the apparatus is an extreme ultraviolet mask
83 blank.

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85 20. The apparatus of Claim 19, wherein the extreme ultraviolet mask blank is processed
86 to form an extreme ultraviolet mask.

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88 21. A system, the system comprising:
89 an extreme ultraviolet (EUV) source to produce extreme ultraviolet radiation;
90 a first reflective guiding module to receive and direct the extreme ultraviolet radiation;

91 an extreme ultraviolet mask to reflect the extreme ultraviolet radiation from the first
92 reflective guiding module and produce reflected radiation having a spatial pattern, the
93 extreme ultraviolet mask comprising:

94 a first multilayer of thin films being adapted for smoothing surface defects on a
95 extreme ultraviolet mask substrate; and

96 a second multilayer of thin films on top of the first multilayer of thin films
97 comprising a reflective multilayer for extreme ultraviolet radiation, the second
98 multilayer of thin films being deposited with a different deposition process than the
99 first multilayer of thin films;

100 a second reflective guiding module to receive the reflected radiation from the extreme
101 ultraviolet mask; and

102 a substrate platform to hold a substrate for exposure to the reflected radiation from the
103 second reflective guiding module.

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105 22. The system of Claim 21, wherein the first multilayer of thin films comprises 20 to 40
106 alternating layers of thin films and the second multilayer of thin films comprises 40 to 60
107 alternating layers of thin films, wherein the alternating layers of thin films comprise a first
108 film and a second film with different optical properties.

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110 23. The system of Claim 22, wherein the alternating layers of thin films comprise one of
111 Molybdenum and Silicon thin films, Molybdenum and Beryllium thin films, and
112 Molybdenum and Silicon compound thin films, wherein the Silicon compound comprises one
113 of Silicon Nitride and Silicon Dioxide.

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115 24. The system of Claim 21, wherein the extreme ultraviolet mask substrate comprises
116 one of a low thermal expansion substrate and a glass substrate.

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118 25. The system of Claim 21, wherein the second multilayer of thin films comprises fewer
119 defects than the first multilayer of thin films.

121 26. The system of Claim 25, wherein the first multilayer of thin films is deposited with
122 ion beam deposition, and the second multilayer of thin films is deposited with atomic layer
123 deposition.

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125 27. An apparatus, the apparatus comprising:

126 a low thermal expansion substrate;
127 a first multilayer of thin films on top of the low thermal expansion substrate, the first
128 multilayer of thin films being deposited with ion beam deposition; and
129 a second multilayer of thin films on top of the first multilayer of thin films, the second
130 multilayer of thin films comprising a multilayer reflective to extreme ultraviolet radiation,
131 the second multilayer of thin films being deposited with atomic layer deposition.

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133 28. The apparatus of Claim 27, wherein the first multilayer of thin films comprises 20 to
134 40 alternating layers of thin films and the second multilayer of thin films comprises 40 to 60
135 alternating layers of thin films, wherein the alternating layers of thin films comprise one of
136 Molybdenum and Silicon thin films, Molybdenum and Beryllium thin films, and
137 Molybdenum and Silicon compound thin films, wherein the Silicon compound comprises one
138 of Silicon Nitride and Silicon Dioxide.

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140 29. The apparatus of Claim 28, wherein the apparatus further comprises:
141 a patterned buffer layer on top of the second multilayer of thin films, the patterned buffer
142 layer comprising an oxide layer; and
143 a patterned absorber layer on top of the patterned buffer layer, the patterned absorber
144 layer comprising a metal.

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